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Kaoru YAMADA et al. : Docket No. 2006-0044A
Serial No. 10/564,980 : Group Art Unit 1792
Filed January18, 2006 :Examiner WALDBAUM, SAMUEL A
SUBSTRATE PROCESSING APPARATUS,
SUBSTRATE PROCESSING METHOD, AND
SUBSTRATE HOLDING APPARATUS

VERIFYING DECLARATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Tetsuya Hirosawa, declare and say:

that I am thoroughly conversant in both the Japanese and English languages;

that I am presently engaged as a translator in these languages;

that the attached document represents a true English translation of Japanese Patent Application No. 2003-289443 filed on August 7, 2003.

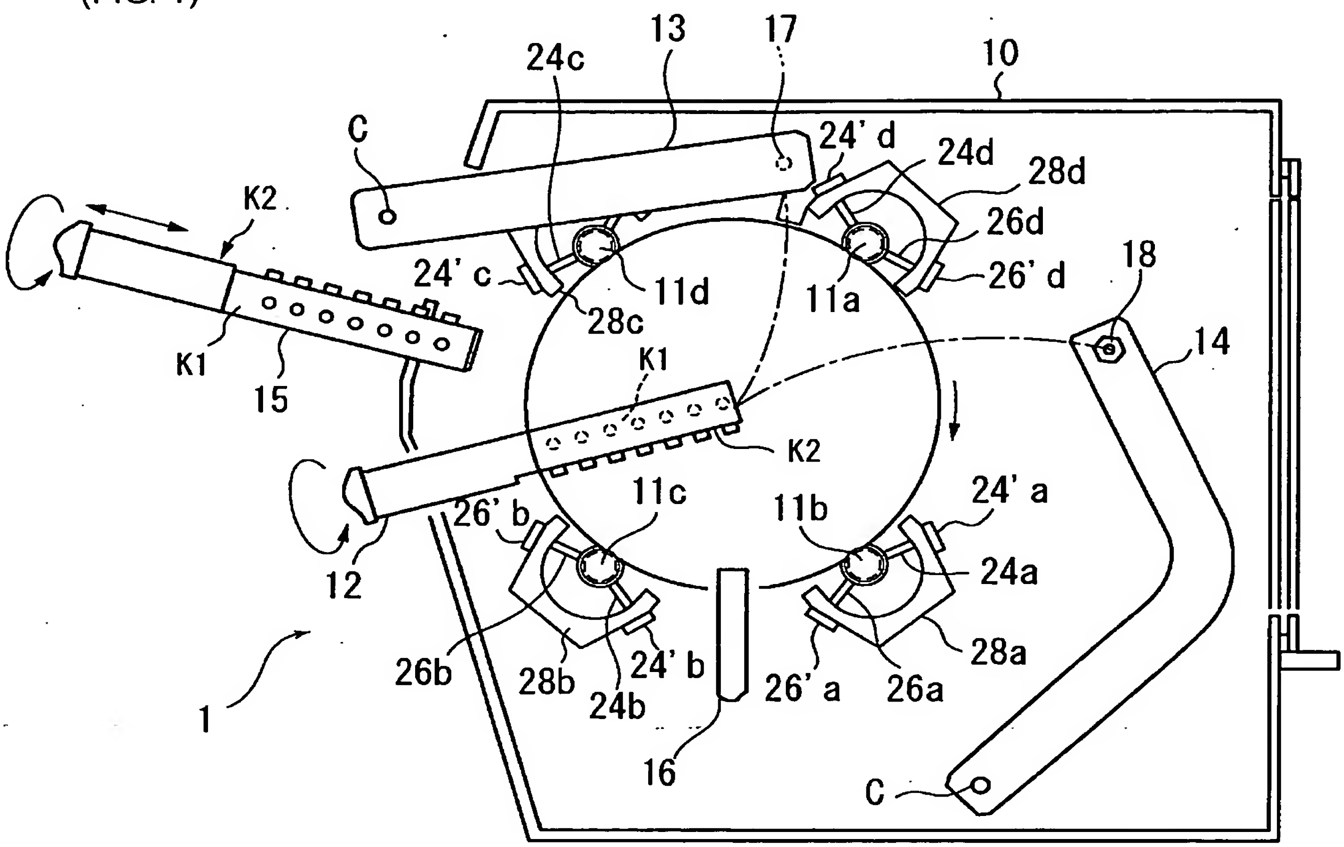
I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that there statements were made with the knowledge that willful false statements and like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 20th day of February, 2009

Tetsuya Hirosawa

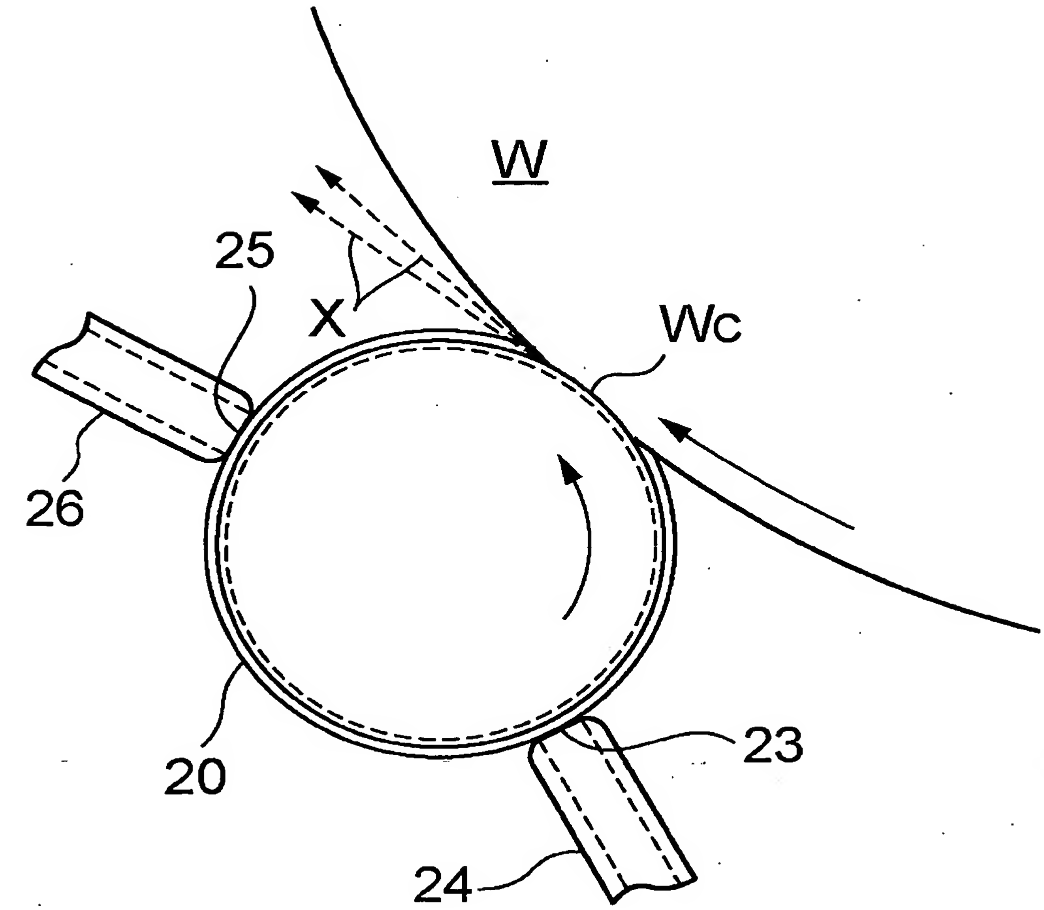
Tetsuya Hirosawa
TRANSLATOR

REFERENCE NUMBER EB3155P
(NAME OF DOCUMENT) DRAWINGS
(FIG. 1)

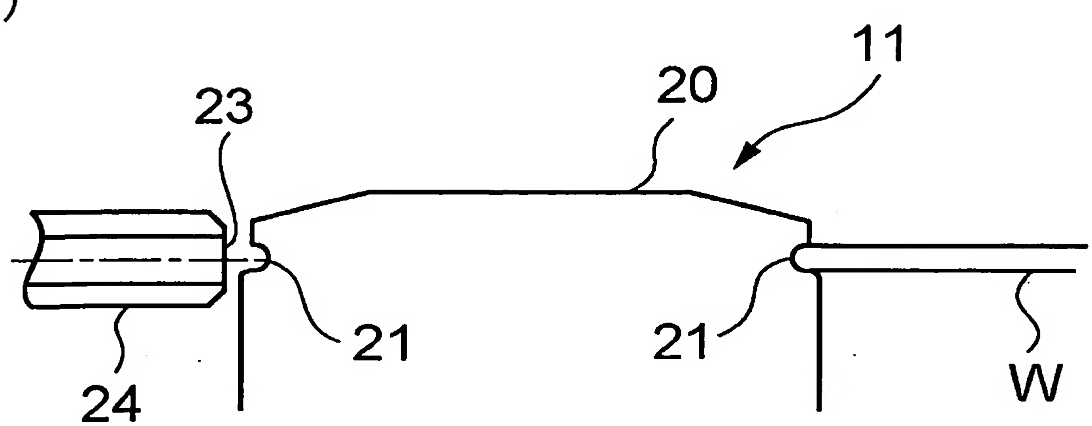


REFERENCE NUMBER EB3155P
(FIG. 2)

(a)

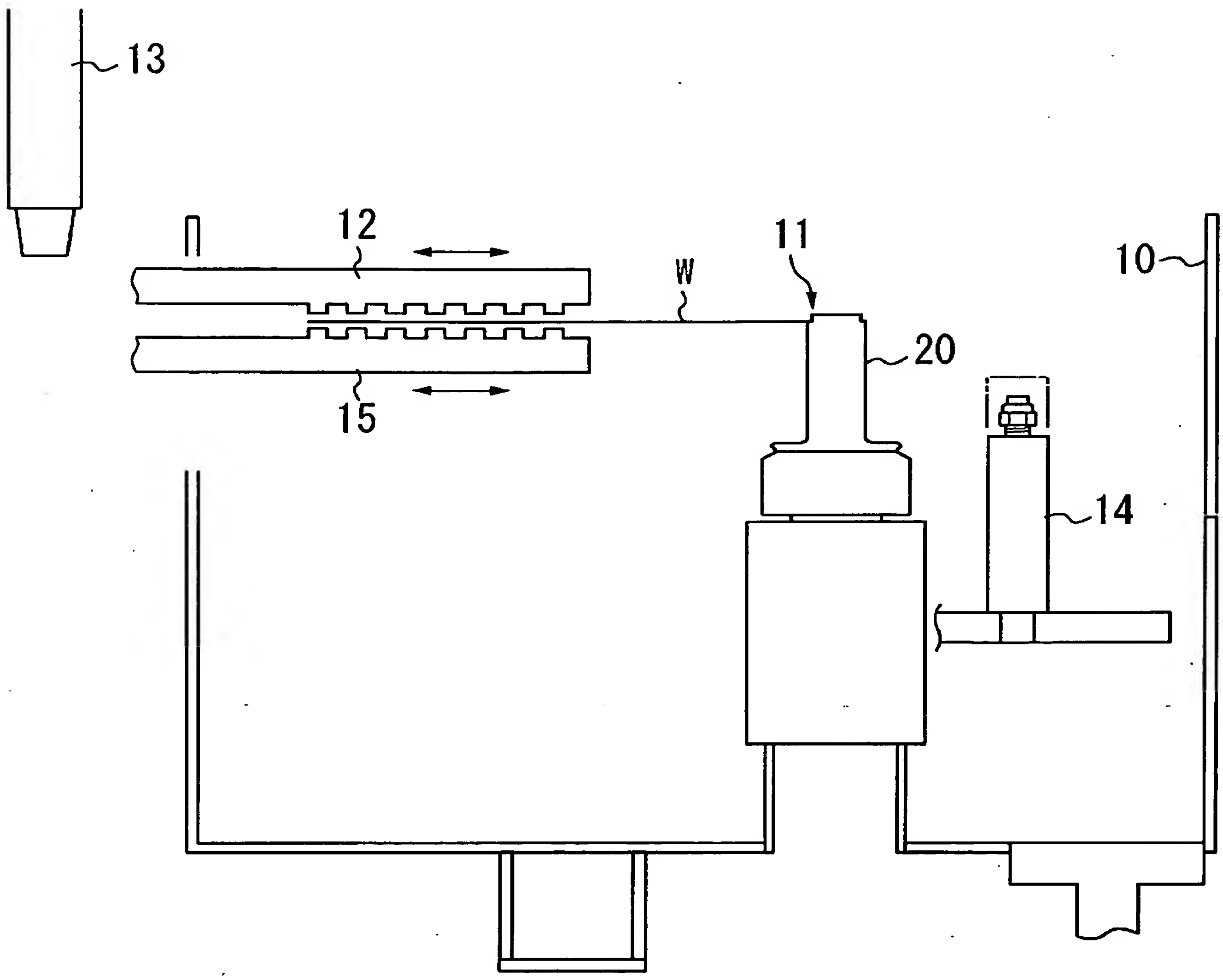


(b)



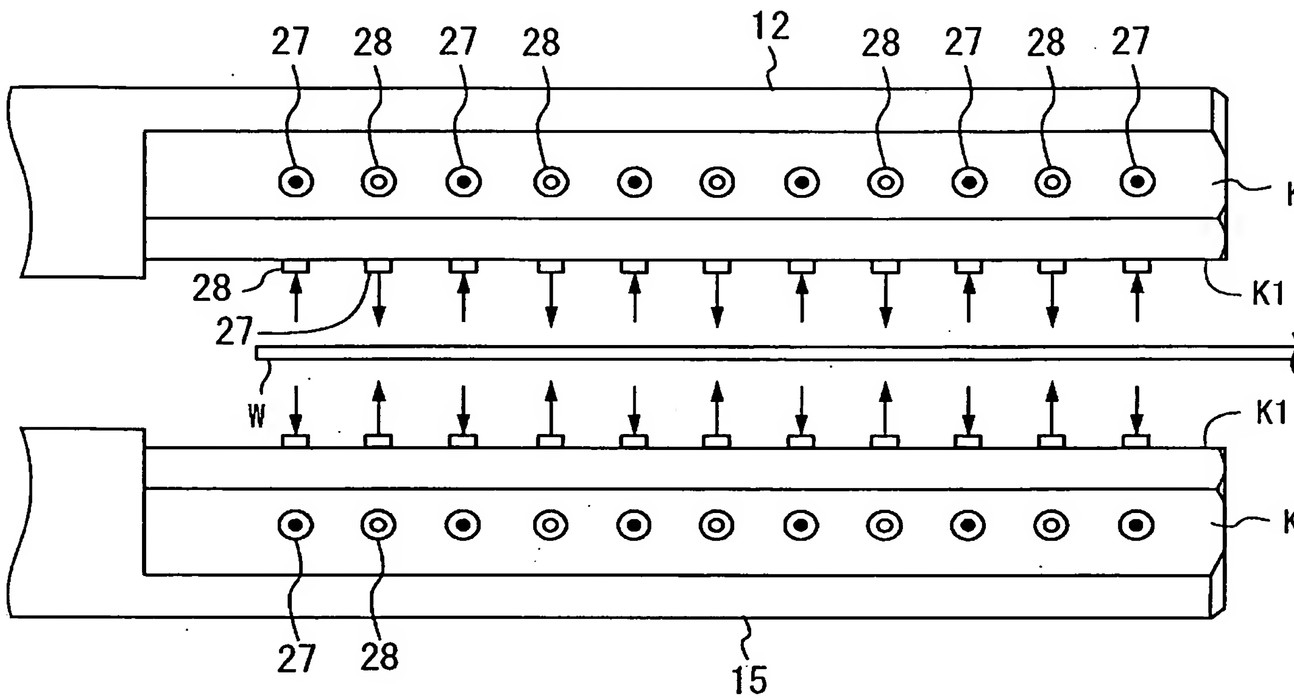
REFERENCE NUMBER EB3155P

(FIG. 3)

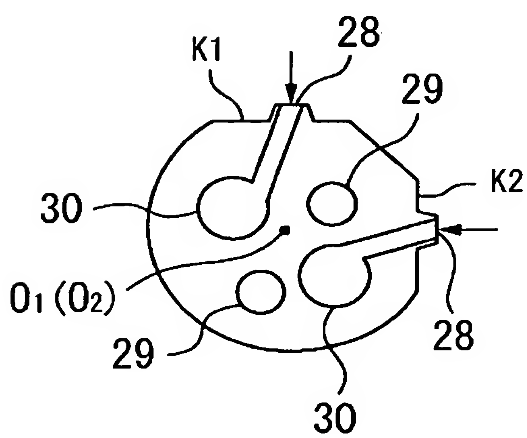


(FIG. 4)

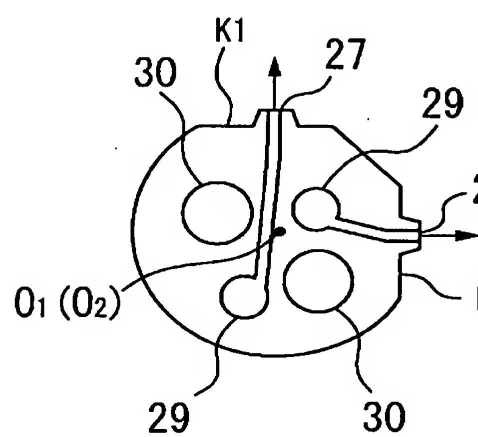
(a)


27 28 27 28
12
28 27 28 27
K2
28
27
K1
W
K1
K2
27 28
15

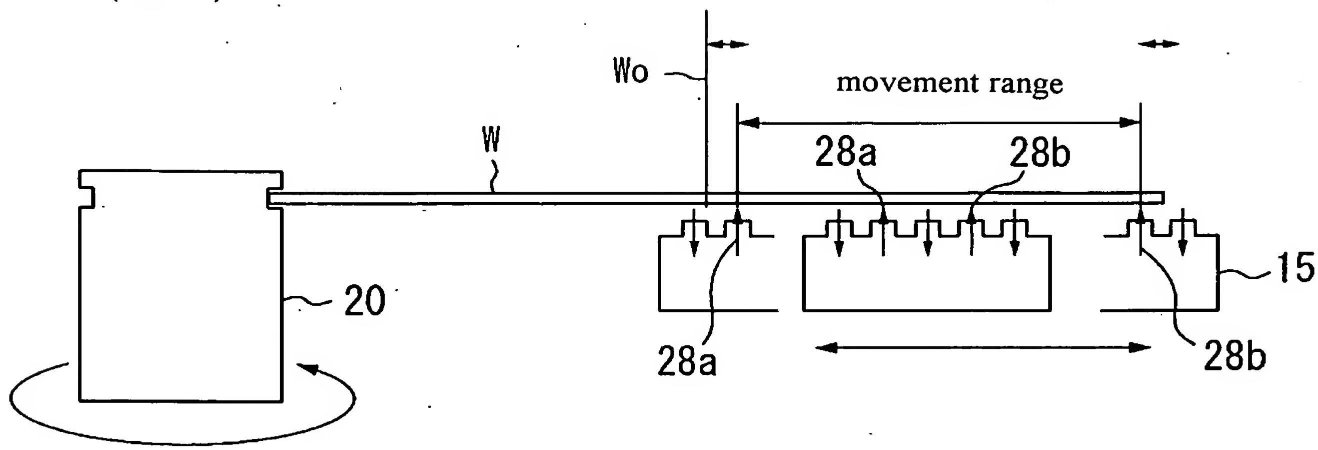
(b)


K1
28
29
30
K2
01 (02)
29
28
30

(c)

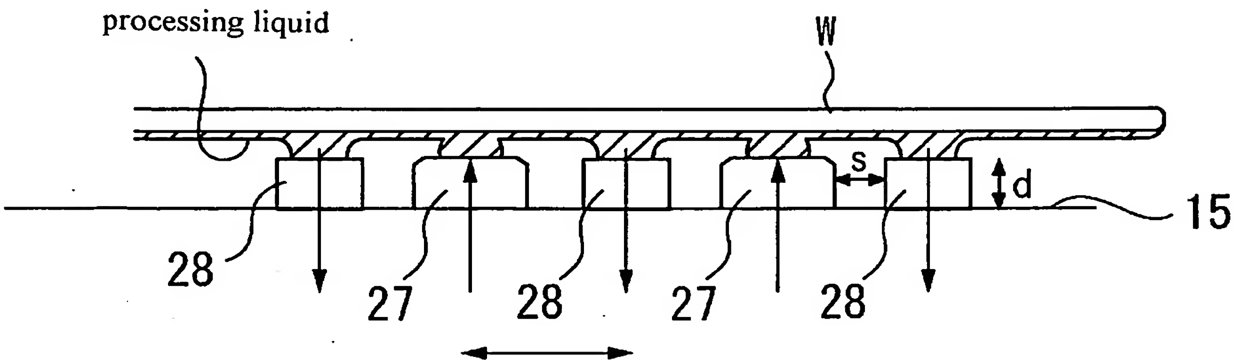

K1
30
27
29
27
01 (02)
K2
29
30

(FIG. 5)

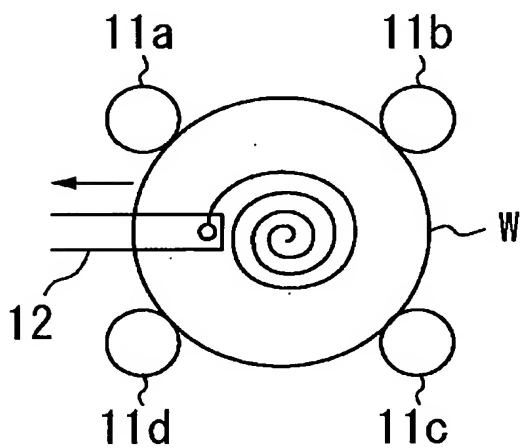


(FIG. 6)

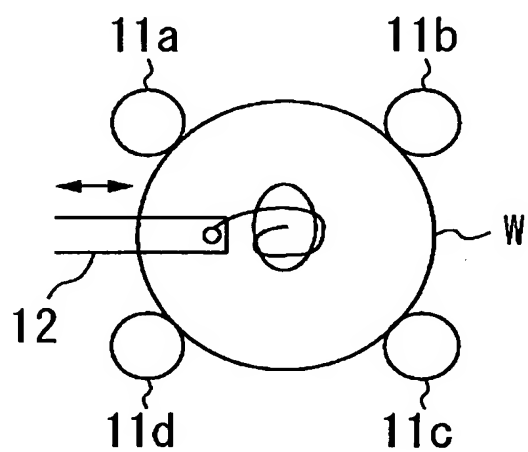
(a)


processing liquid
W
s
d
15
28
27
28
27
28

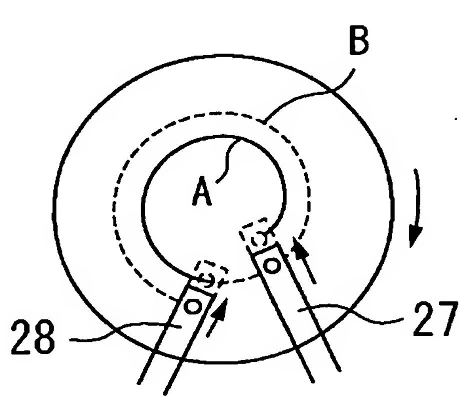
(b)


11a
11b
W
12
11d
11c

(c)

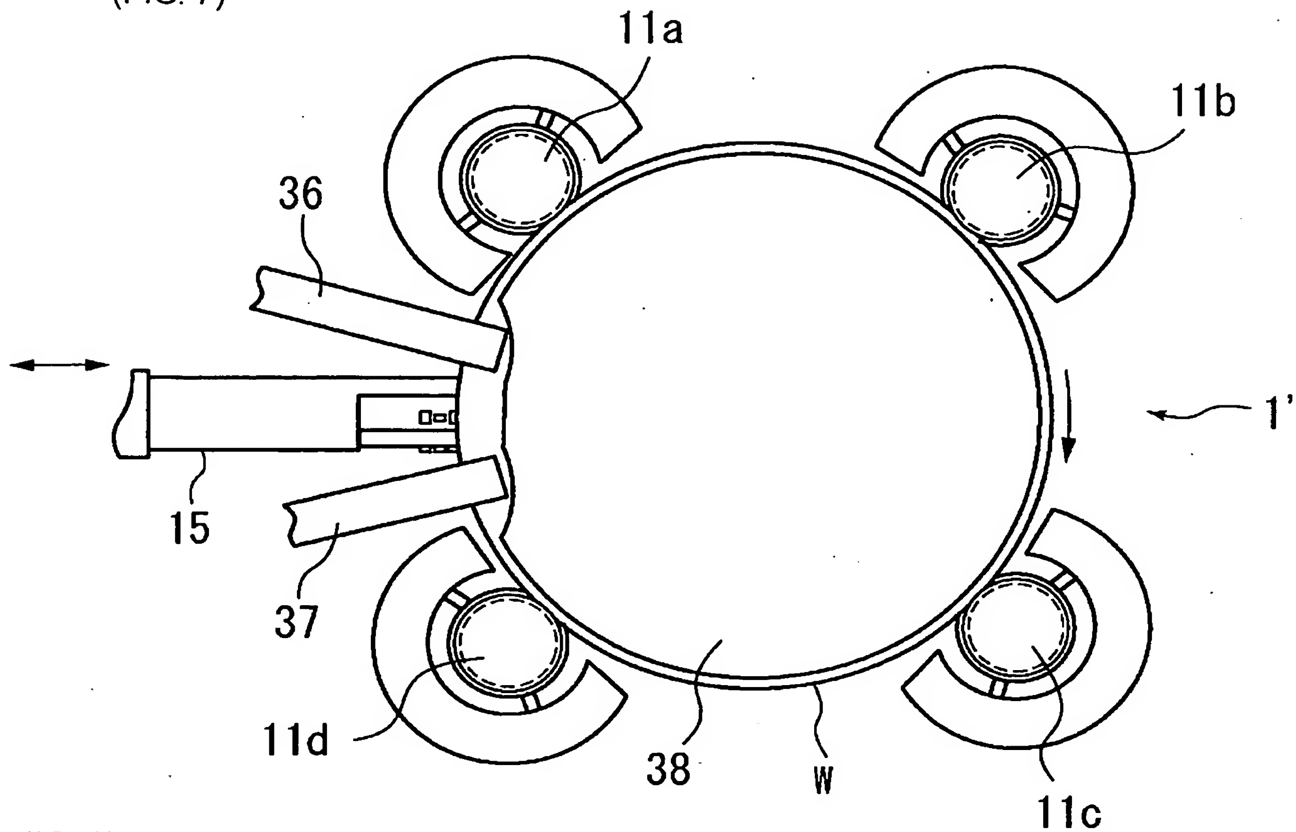

11a
11b
W
12
11d
11c

(d)

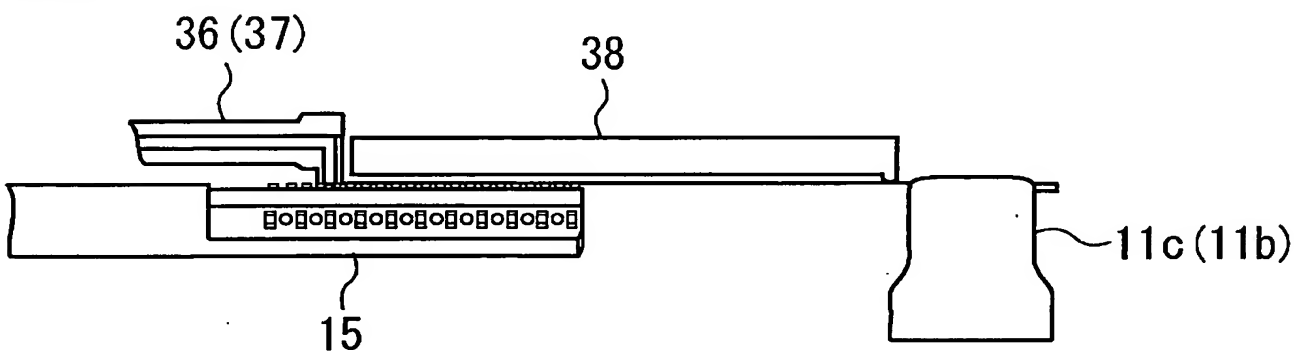

B
A
28
27

REFERENCE NUMBER EB3155P

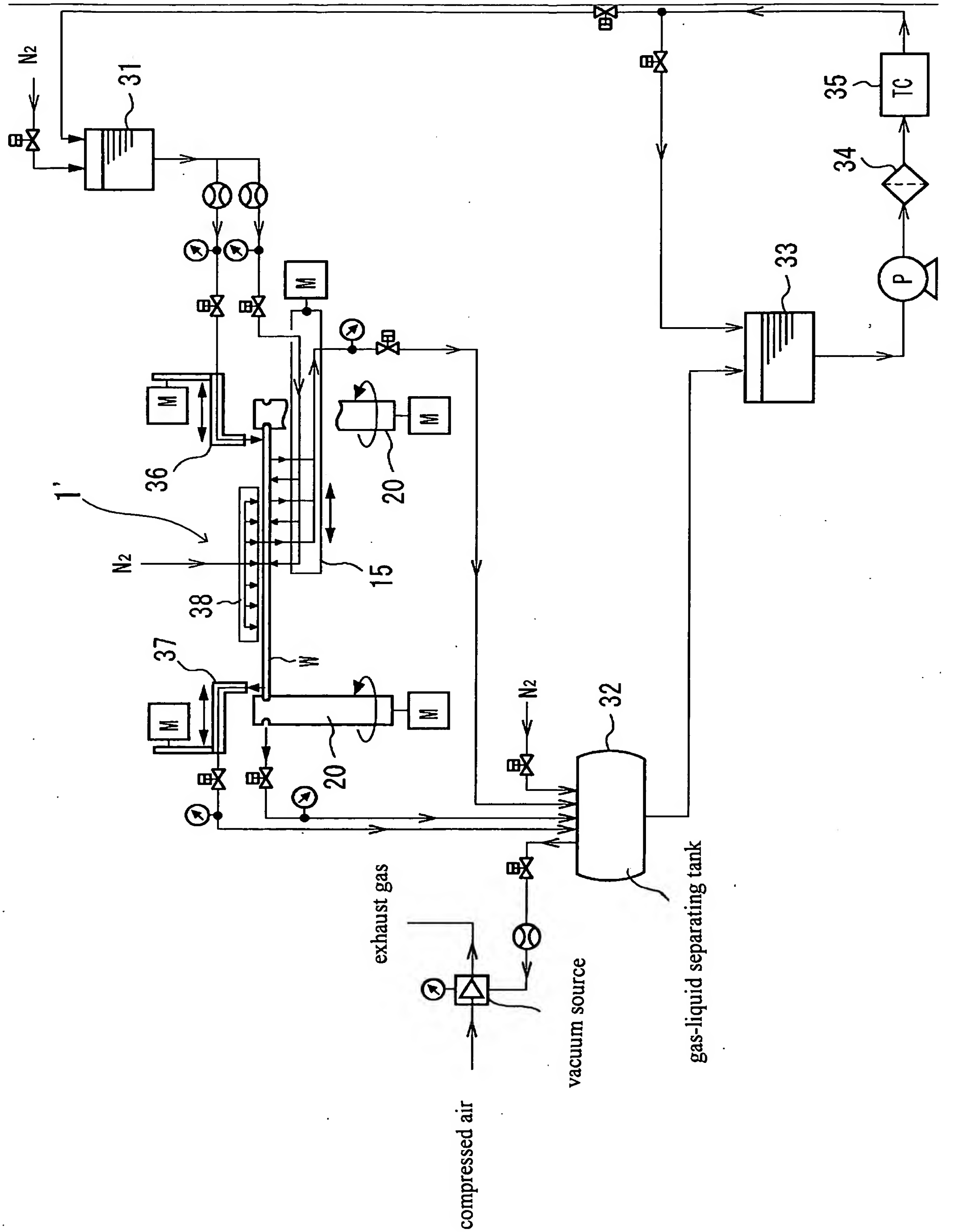
(FIG. 7)



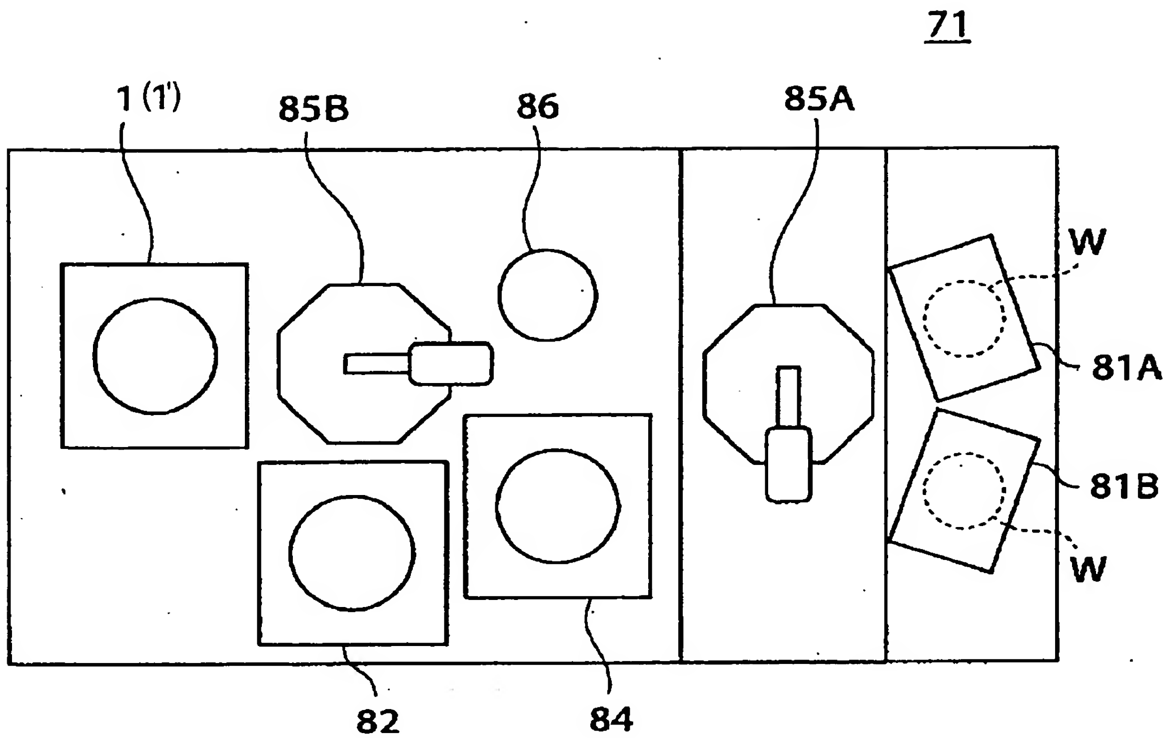
(FIG. 8)



(FIG. 9)


N2
31
35
TC
34
33
P
M
36
1'
N2
38
15
20
37
W
20
N2
32
exhaust gas
vacuum source
gas-liquid separating tank
compressed air

REFERENCE NUMBER EB3155P
(FIG. 10)



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(DESTINATION) DIRECTOR GENERAL OF THE PATENT OFFICE

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(INVENTOR)

(ADDRESS) c/o Ebara Research Co., Ltd.
2-1, Honfujisawa 4-chome, Fujisawa-shi, Kanagawa

(NAME) Kaoru YAMADA

(INVENTOR)

(ADDRESS) c/o Ebara Corporation
11-1, Haneda Asahi-cho, Ohta-ku, Tokyo

(NAME) Ichiro KATAKABE

(INVENTOR)

(ADDRESS) c/o Ebara Corporation
11-1, Haneda Asahi-cho, Ohta-ku, Tokyo

(NAME) Kenya ITO

(INVENTOR)

(ADDRESS) c/o Ebara Corporation
11-1, Haneda Asahi-cho, Ohta-ku, Tokyo

(NAME) Masayuki KAMEZAWA

(INVENTOR)

(ADDRESS) c/o Ebara Corporation
11-1, Haneda Asahi-cho, Ohta-ku, Tokyo

(NAME) Masaya SEKI

(INVENTOR)

(ADDRESS) c/o Ebara Corporation
11-1, Haneda Asahi-cho, Ohta-ku, Tokyo

(NAME) Sumio YABE

(INVENTOR)

(ADDRESS) c/o Ebara Research Co., Ltd.
2-1, Honfujisawa 4-chome, Fujisawa-shi, Kanagawa

(NAME) Takayuki SAITO

(APPLICANT)

(IDENTIFICATION NUMBER) 00000239

(THE NAME OF APPLICANT) EBARA CORPORATION

(REPRESENTATIVE) Masatoshi YODA

(PATENT ATTORNEY)

(IDENTIFICATION NUMBER) 100091498

(NAME) Isamu WATANABE

(PATENT ATTORNEY)

(IDENTIFICATION NUMBER) 100092406

(NAME) Shintaro HOTTA

(PATENT ATTORNEY)

(IDENTIFICATION NUMBER) 100093942

(NAME) Ryoji KOSUGI

(PATENT ATTORNEY)

(IDENTIFICATION NUMBER) 100109896

(NAME) Tomohiro MORI

(OFFICIAL FEE)

(REGISTERED NUMBER FOR PAYMENT) 026996

(AMOUNT)	21000	
(LIST OF DOCUMENT FILED)		
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(THE NAME OF DOCUMENT)	DRAWINGS	1
(THE NAME OF DOCUMENT)	ABSTRACT	1
(THE NUMBER OF GENERAL POWER OF ATTORNEY)		9112447
(THE NUMBER OF GENERAL POWER OF ATTORNEY)		0018636

(NAME OF DOCUMENT) CLAIMS

(CLAIM 1)

A substrate processing apparatus comprising:

a substrate holder for holding and rotating a substrate;

at least one fluid supply port for supplying a fluid to the substrate which is being rotated; and

at least one fluid suction port for sucking the fluid on the substrate;

wherein said fluid supply port and said fluid suction port are disposed close to the substrate.

(CLAIM 2)

A substrate processing apparatus according to claim 1, wherein the fluid is a liquid.

(CLAIM 3)

A substrate processing apparatus according to claim 1 or 2, wherein said fluid supply port and said fluid suction port are reciprocated in a radial direction of the substrate.

(CLAIM 4)

A substrate processing apparatus according to any one of claims 1 to 3, wherein a plurality of said fluid supply ports and a plurality of said fluid suction ports are disposed alternately.

(CLAIM 5)

A substrate processing apparatus according to any one of claims 1 to 4, wherein a plurality of said fluid supply ports and/or a plurality of said fluid suction ports are arranged linearly.

(CLAIM 6)

A substrate processing apparatus according to any one of claims 1 to 5, wherein a plurality of said fluid supply ports are spaced from a surface of the substrate by an equal distance.

(CLAIM 7)

A substrate processing apparatus according to any one of claims 1 to 5, wherein

a plurality of said fluid suction ports are spaced from a surface of the substrate by an equal distance.

(CLAIM 8)

A substrate processing apparatus according to any one of claims 1 to 7, wherein at least one of said fluid supply port and said fluid suction port is disposed at an upper side and/or a lower side of the substrate.

(CLAIM 9)

A substrate processing apparatus according to any one of claims 1 to 8, said substrate holder is brought into contact with the substrate so as to hold and rotate the substrate substantially horizontally by utilizing friction between said substrate holder and the substrate.

(CLAIM 10)

A substrate processing apparatus according to claim 9, further comprising a holder suction unit for sucking the fluid which has adhered to said substrate holder.

(CLAIM 11)

A substrate processing apparatus according to claim 9 or 10, further comprising a holder cleaning unit for supplying a cleaning fluid to said substrate holder.

(CLAIM 12)

A substrate processing apparatus according to any one of claims 9 to 11, further comprising a periphery suction unit for sucking the fluid from a peripheral portion of the substrate, said periphery suction unit being located close to the peripheral portion of the substrate.

(CLAIM 13)

A substrate processing apparatus according to any one of claims 1 to 12, further comprising:

a substrate cleaning unit having said fluid supply ports and said fluid suction ports;

wherein said substrate cleaning unit has a first operation section in which said fluid supply ports and said fluid suction ports are disposed linearly and alternately.

(CLAIM 14)

A substrate processing apparatus according to claim 13, wherein said substrate cleaning unit has a second operation section in which fluid supply ports and/or fluid suction ports for a different processing fluid are disposed linearly.

(CLAIM 15)

A substrate processing apparatus according to claim 14, wherein said substrate cleaning unit is operable to switch said first operation section and said second operation section therebetween.

(CLAIM 16)

A substrate processing apparatus according to any one of claims 1 to 15, further comprising a flow-rate controller for the fluid to be supplied from said fluid supply port.

(CLAIM 17)

A substrate processing apparatus according to any one of claims 1 to 16, wherein flow rates of the fluid to be supplied respectively from a plurality of said fluid supply ports are adjusted such that the flow rates are increased gradually from a central side to a peripheral side of the substrate.

(CLAIM 18)

A substrate processing apparatus according to any one of claims 1 to 17, further comprising a flow-rate monitor for monitoring a flow rate of the fluid to be supplied from at least one of said fluid supply ports.

(CLAIM 19)

A substrate processing apparatus according to any one of claims 1 to 18, further comprising a temperature controller for controlling a temperature of the fluid.

(CLAIM 20)

A substrate processing apparatus according to any one of claims 1 to 19, wherein a period of reciprocating movement of said fluid supply port and said fluid suction port is longer than a rotational period of the substrate.

(CLAIM 21)

A substrate processing apparatus according to any one of claims 1 to 20, wherein the fluid supply port and the fluid suction port perform a reciprocating movement and are stopped at stroke ends for not more than 0.5 second.

(CLAIM 22)

A substrate processing apparatus according to any one of claims 1 to 21, wherein the fluid supply port and the fluid suction port perform a reciprocating movement in a radial direction of the substrate within a movement range which does not include a central portion and an edge portion of the substrate.

(CLAIM 23)

A substrate processing apparatus according to any one of claims 1 to 22, further comprising a cleaning unit for cleaning a peripheral portion of the substrate.

(CLAIM 24)

A substrate processing apparatus according to any one of claims 1 to 23, further comprising at least one gas supply nozzle having a gas supply mouth through which an inert gas or a low humidity gas is supplied to the substrate.

(CLAIM 25)

A substrate processing apparatus according to any one of claims 1 to 24, further comprising a recovery tank for reusing the fluid which has been sucked and recovered through said fluid suction ports.

(CLAIM 26)

A substrate processing apparatus according to claim 25, further comprising a unit for regenerating the recovered fluid.

(CLAIM 27)

A substrate processing apparatus according to claim 25 or 26, further comprising a unit for monitoring a concentration of the recovered or regenerated fluid, and/or a concentration of impurities contained in the fluid.

(CLAIM 28)

A substrate processing method, comprising:

rotating a substrate;

supplying a fluid from at least one fluid supply port to the substrate which is being rotated; and

sucking the fluid on the substrate through at least one fluid suction port;

wherein said fluid supply port and said fluid suction port are disposed close to the substrate.

(CLAIM 29)

A substrate processing method according to claim 28, wherein flow rates of the fluid supplied respectively from a plurality of said fluid supply ports are adjusted such that the flow rates are increased gradually from a central side to a peripheral side of the substrate.

(CLAIM 30)

A substrate processing method according to claim 28 or 29, wherein said fluid supply port and said fluid suction port are reciprocated in a radial direction of the substrate, and a period of reciprocating movement of said fluid supply port and said fluid suction port is longer than a rotational period of the substrate.

(NAME OF DOCUMENT) SPECIFICATION

(TITLE OF THE INVENTION) SUBSTRATE PROCESSING APPARATUS AND SUBSTRATE PROCESSING METHOD

(TECHNICAL FIELD TO WHICH THE INVENTION BELONGS)

(0001)

The present invention relates to a substrate processing apparatus and a substrate processing method for performing a chemical liquid process, a cleaning process, a drying process, or the like while rotating a substrate such as a semiconductor wafer or a liquid crystal substrate.

(BACKGROUND ART)

(0002)

In the semiconductor fabricating process, as a diameter of a semiconductor wafer becomes large, a single-wafer processing apparatus is being introduced in an increasing number of wet processes. A spin-type processing apparatus is widely known as the single wafer processing apparatus for use in a wet process, and is applied to a cleaning apparatus and a drying apparatus for a semiconductor wafer (see patent document 1 and patent document 2).

The above-mentioned spin-type processing apparatus is operated as follows. A substrate is rotated at a high speed by a substrate holder such as a spin chuck, and a chemical liquid is supplied to the substrate, which is being rotated, to clean the substrate. Thereafter, a cleaning liquid such as ultrapure water is supplied to wash out the chemical liquid, and then the substrate is rotated at a higher speed to remove the cleaning liquid, so that the substrate is dried.

(0003)

(Patent document 1) Japanese patent publication No. 2002-52370

(Patent document 2) Japanese patent publication No. 2003-163195

(0004)

However, in the conventional processing apparatus described above, particularly in the cleaning apparatus, a very large amount of liquid is scattered around from the substrate, and as a result a large amount of liquid is used. Moreover, the shattered

liquid causes in turn contamination to the substrate. The conventional spin-type processing apparatus is also problematic in terms of a uniform process over the entire surface of the substrate because the liquid is supplied only to one portion such as a central portion of the substrate and spreads over the entire surface of the substrate by the rotation of the substrate.

(DISCLOSURE OF THE INVENTION)

(PROBLEMS TO BE SOLBED BY THE INVENTION)

(0005)

The present invention has been made in view of the above drawbacks. It is, therefore, an object of the present invention to provide a substrate processing apparatus and a substrate processing method which can prevent a fluid such as a processing liquid from being scattered from a substrate and can reduce an amount of the liquid to be used and can improve a uniformity of a process on the surface of the substrate.

(MEANS FOR COLVING THE PROBLEMS)

(0006)

In order to achieve the above objects, according to an aspect of the present invention, there is provided a substrate processing apparatus comprising: a substrate holder for holding and rotating a substrate; at least one fluid supply port for supplying a fluid to the substrate which is being rotated; and at least one fluid suction port for sucking the fluid on the substrate; wherein said fluid supply port and said fluid suction port are disposed close to the substrate.

(0007)

In a preferred aspect of the present invention, the fluid is a liquid.

In a preferred aspect of the present invention, said fluid supply port and said fluid suction port are reciprocated in a radial direction of the substrate.

In a preferred aspect of the present invention, a plurality of said fluid supply ports and a plurality of said fluid suction ports are disposed alternately.

(0008)

In a preferred aspect of the present invention, a plurality of said fluid supply ports and/or a plurality of said fluid suction ports are disposed linearly.

In a preferred aspect of the present invention, a plurality of said fluid supply ports are spaced from a surface of the substrate by an equal distance.

In a preferred aspect of the present invention, a plurality of said fluid suction ports are spaced from a surface of the substrate by an equal distance.

(0009)

In a preferred aspect of the present invention, at least one of said fluid supply port and said fluid suction port is disposed at an upper side and/or a lower side of the substrate.

In a preferred aspect of the present invention, said substrate holder is brought into contact with the substrate so as to hold and rotate the substrate substantially horizontally by utilizing friction between said substrate holder and the substrate.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a holder suction unit for sucking the fluid which has adhered to said substrate holder.

(0010)

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a holder cleaning unit for supplying a cleaning fluid to said substrate holder.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a periphery suction unit for sucking the fluid from a peripheral portion of the substrate.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a substrate cleaning unit having said fluid supply ports and said fluid suction ports; wherein said substrate cleaning unit has a first operation section in which said fluid supply ports and said fluid suction ports are disposed linearly and alternately.

(0011)

In a preferred aspect of the present invention, said substrate cleaning unit has a second operation section in which fluid supply ports and/or fluid suction ports for a different processing fluid are disposed linearly.

In a preferred aspect of the present invention, said substrate cleaning unit is

operable to switch said first operation section and said second operation section therebetween.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a flow-rate controller for the fluid to be supplied from said fluid supply port.

(0012)

In a preferred aspect of the present invention, flow rates of the fluid to be supplied respectively from a plurality of said fluid supply ports are adjusted such that the flow rates are increased gradually from a central side to a peripheral side of the substrate.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a flow-rate monitor for monitoring a flow rate of the fluid to be supplied from at least one of said fluid supply ports.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a temperature controller for controlling a temperature of the fluid.

(0013)

In a preferred aspect of the present invention, a period of reciprocating movement of said fluid supply port and said fluid suction port is longer than a rotational period of the substrate.

In a preferred aspect of the present invention, the fluid supply port and the fluid suction port perform a reciprocating movement and are stopped at stroke ends for not more than 0.5 second.

In a preferred aspect of the present invention, the fluid supply port and the fluid suction port perform a reciprocating movement in a radial direction of the substrate within a movement range which does not include a central portion and an edge portion of the substrate.

(0014)

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a cleaning unit for cleaning a peripheral portion of the substrate.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises at least one gas supply nozzle having a gas supply mouth through

which an inert gas or a low humidity gas is supplied to the substrate.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a recovery tank for reusing the fluid which has been sucked and recovered through said fluid suction ports.

(0015)

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a unit for regenerating the recovered fluid.

In a preferred aspect of the present invention, the substrate processing apparatus further comprises a unit for monitoring a concentration of the recovered or regenerated fluid, and/or a concentration of impurities contained in the fluid.

(0016)

Another aspect of the present invention is to provide a substrate processing method, comprising: rotating a substrate; supplying a fluid from at least one fluid supply port to the substrate which is being rotated; and sucking the fluid on the substrate through at least one fluid suction port; wherein said fluid supply port and said fluid suction port are disposed close to the substrate.

In a preferred aspect of the present invention, flow rates of the fluid supplied respectively from a plurality of said fluid supply ports are adjusted such that the flow rates are increased gradually from a central side to a peripheral side of the substrate.

In a preferred aspect of the present invention, said fluid supply port and said fluid suction port are reciprocated in a radial direction of the substrate, and a period of reciprocating movement of said fluid supply port and said fluid suction port is longer than a rotational period of the substrate.

(EFFECT OF THE INVENTION)

(0017)

The present invention can improve the uniformity of processing the surface of the substrate; can reduce an amount of the fluid (liquid) to be used; and can prevent scattering of the processing fluid (liquid).

(BEST MODE FOR PERFORMING THE PRESENT INVENTION)

(0018)

FIG. 1 is a plan view schematically showing a substrate processing apparatus according to an embodiment of the present invention. This substrate processing apparatus 1 comprises a chamber 10, and substrate holders 11 (11a, 11b, 11c and 11d) disposed in the chamber 10. A substrate W, such as a semiconductor wafer, is accommodated in the chamber 10, and is held and rotated by the substrate holders 11a, 11b, 11c and 11d. Holder suction nozzles (i.e., holder suction units) 24 (24a, 24b, 24c and 24d) and holder cleaning nozzles (i.e., holder cleaning units) 26 (26a, 26b, 26c and 26d) are disposed close to the substrate holders 11. The holder suction nozzles 24a, 24b, 24c and 24d and the holder cleaning nozzles 26a, 26b, 26c and 26d are supported by support members 28a, 28b, 28c and 28d, respectively. Clearances between the respective holder suction nozzles 24 and the respective substrate holders 11 can be adjusted by adjusters 24' (24a', 24b', 24c' and 24d'), respectively, and clearances between the respective holder cleaning nozzles 26 and the respective substrate holders 11 can be adjusted by adjusters 26' (26a', 26b', 26c' and 26d'), respectively. Cleaning nozzles (i.e., substrate cleaning units) 12 and 15 are disposed at an upper surface side and a lower surface side of the substrate W, respectively. Each of the cleaning nozzles 12 and 15 has plural fluid supply ports and plural fluid suction ports.

(0019)

Gas supply nozzles 13 and 14 are disposed at the upper surface side and the lower surface side of the substrate W, respectively, so that a drying gas, such as an inert gas (e.g., an N_2 gas) or a dry air having a humidity of not more than 10 %, is supplied from each of the gas supply nozzles 13 and 14 to the substrate W. The gas supply nozzles 13 and 14 have gas supply mouths 17 and 18, respectively. Each of these gas supply nozzles 13 and 14 is swingable about a fulcrum C in the substantially radial direction of the substrate W as indicated by a chain line in the drawing. The substrate processing apparatus also comprises a bevel suction nozzle 16 serving as a periphery suction unit for sucking a fluid (e.g., liquid) on a peripheral portion of the substrate W. Although the four substrate holders 11 are provided in this embodiment as shown in the drawing, the number of substrate holders 11 is not limited to four, and three or more

substrate holders may be provided. Examples of the fluid to be supplied from the cleaning nozzles 12 and 15 include a cleaning fluid, an etching liquid, and an etching gas. Specifically, a corrosive gas (e.g. hydrogen fluoride), an acid (e.g. fluorinated acid), an oxidizing agent (e.g. hydrogen peroxide, nitric acid, or ozone), an alkaline agent (e.g. ammonia), a chelating agent, a surface active agent, or a combination of these may be used.

(0020)

The substrate holders 11 rotate the substrate W by utilizing friction between the substrate W and the substrate holders 11. According to such substrate holders 11, the gas supply nozzles 13 and 14 can be disposed near the upper and lower surfaces of the substrate W. In a case of a spin-chuck-type substrate holder, a spin chuck should be disposed underneath a substrate, and hence the spin chuck makes it difficult to dispose a swingable gas supply nozzle near a lower surface of the substrate.

(0021)

FIGS. 2(a) and 2(b) are views showing a structure of the substrate holder. The substrate holders (rotating holders) 11 for holding the substrate W comprise rollers 20, respectively, and each of the rollers 20 has a clamp portion 21 formed on its circumferential surface. The rollers 20 are brought into contact with an edge portion of the substrate W under predetermined pressing forces which are toward a substantially center of the substrate W. All the substrate holders 11 are rotated by at least one rotating mechanism such as a motor (not shown) at a predetermined rotational speed in the same direction. The substrate holders 11 impart a rotational force to the substrate W due to friction between the substrate holders 11 and the edge portion of the substrate W while holding the substrate W. At least one of the substrate holders 11 may be rotated by the rotating mechanism. The holder suction nozzles 24 are disposed close to the clamp portions 21 of the rollers 20, respectively, and each of the holder suction nozzles 24 has a suction mouth 23 for sucking a fluid such as a processing liquid. The suction mouth 23 is positioned close to the clamp portion 21 with a distance of not more than 5 mm, for example, so as to suck the fluid that has adhered to the clamp portion 21. Similarly, the holder cleaning nozzles 26 are disposed close to the clamp portions 21 of

the rollers 20, respectively, and each of the holder cleaning nozzles 26 has a supply mouth 25 for supplying a cleaning fluid such as a cleaning liquid to the clamp portion 21. By sucking the liquid on the substrate holders, replacement of the liquid on the periphery of the substrate can be improved and the scattering of the liquid can be prevented. Even when the substrate is rotated in a low speed, the liquid can be removed by the suction from the periphery of the substrate. Therefore, uniform processing over the surface of the substrate can be realized.

(0022)

If the roller 20 is rotated in a direction indicated by arrow in FIG. 2(a), the holder cleaning nozzle 26 having the supply mouth 25 is located forward of a contact portion Wc between the clamp portion 21 and the substrate W in the rotational direction of the roller 20. Further, the holder suction nozzle 24 having the suction mouth 23 is located forward of the holder cleaning nozzle 26 in the rotational direction of the roller 20. When the roller 20 is rotated in the direction indicated by the arrow in FIG. 2(a), the fluid on the peripheral portion of the substrate W is moved to the clamp portion 21 of the roller 20 via the contact portion Wc, and then the clamp portion 21 to which the fluid has adhered is cleaned with the cleaning fluid supplied from the supply mouth 25 of the holder cleaning nozzle 26. As the roller 20 is rotated, the fluid, which has been processed by the cleaning fluid, reaches in front of the suction mouth 23 of the holder suction nozzle 24, and is then sucked by the holder suction nozzle 24. This arrangement can prevent the fluid from being scattered from the peripheral portion of the substrate W. Therefore, it is possible to prevent contamination of the substrate W and prevent water marks from being produced.

(0023)

FIG. 3 shows the manner in which the substrate processing apparatus shown in FIG. 1 cleans a front surface (an upper surface) and a back surface (a lower surface) of a substrate W. As shown in FIG. 3, an upper-surface-side cleaning nozzle (substrate cleaning unit) 12 is disposed close to the upper surface of the substrate W at a predetermined height. The upper-surface-side cleaning nozzle 12 is supported by an elevating/lowering mechanism (not shown). A lower-surface-side cleaning nozzle

(substrate cleaning unit) 15 is similarly disposed close to the lower surface of the substrate W at a predetermined height. The lower-surface-side cleaning nozzle 15 is also supported by an elevating/lowering mechanism (not shown). In this substrate processing apparatus also, the substrate W is held horizontally by substrate holders 11 comprising rollers 20, so that rotational forces are imparted from the rollers 20 to the substrate W. In FIG. 3, an upper-surface-side gas supply nozzle 13 and a lower-surface-side gas supply nozzle 14 are in retreat positions, respectively. After the substrate W is cleaned, the upper-surface-side cleaning nozzle 12 is moved in the radial direction of the substrate W to a retreat position, and the upper-surface-side gas supply nozzle 13 is moved to a position above the upper surface of the substrate W and then supplies a drying gas to the substrate W to dry the substrate W. Similarly, the lower-surface-side cleaning nozzle 15 is moved in the radial direction of the substrate W to a retreat position below the substrate W, and the lower-surface-side gas supply nozzle 14 is moved to a predetermined position and supplies a drying gas to the lower surface of the substrate W to dry the substrate W.

(0024)

Each of the cleaning nozzles 12 and 15 has fluid supply ports and fluid suction ports which are disposed apart from each other. If a substrate having a diameter of 200 mm is to be processed, then each of the cleaning nozzles 12 and 15 has about ten fluid supply ports and ten fluid suction ports that are disposed alternately. The fluid supply ports supply a fluid (liquid) such as a cleaning liquid to the substrate W, and the fluid (liquid) that has been supplied to the substrate W is sucked through the fluid suction ports. The fluid supply ports and the fluid suction ports are reciprocated while supplying and sucking the fluid, respectively, so as to perform a cleaning process or the like. This process is effective in suppressing the scattering of the fluid from the substrate and minimizing an amount of the fluid that remains on the processed substrate.

(0025)

FIG. 4 shows a specific structure of the cleaning nozzles. Each of the cleaning nozzles 12 and 15 has an operation surface K1 and an operation surface K2 on its side portion. Each of the operation surfaces K1 and K2 has fluid supply ports 27 and fluid

suction ports 28 which are aligned alternately and linearly. As shown in FIG. 4, the each fluid supply port 27 is connected to a common supply pipe (supply passage) 29, and the each fluid suction port 28 is connected to a common discharge pipe (discharge passage) 30. With this structure, when the fluid (e.g., liquid) is supplied to the supply pipe 29, the fluid is supplied from the respective fluid supply ports 27 to the surface of the substrate W. The discharge pipe 30 is connected to a vacuum source and evacuated by the vacuum source, so that the fluid, which has been supplied to the surface of the substrate, is sucked through the respective fluid suction ports 28.

(0026)

In the illustrated embodiment, each of the cleaning nozzles 12 and 15 has two arrays each comprising the fluid supply ports 27 and the fluid suction ports 28. This structure allows the respective cleaning nozzles 12 and 15 to use two types of fluids. Each of the cleaning nozzles 12 and 15 has the two supply pipes 29 and 29 and the two discharge pipes 30 and 30. One pair of the supply pipe 29 and the discharge pipe 30 are connected respectively to the fluid supply ports 27 and the fluid suction ports 28, both of which open at the operation surface K1. Similarly, the other pair of the supply pipe 29 and the discharge pipe 30 are connected respectively to the fluid supply ports 27 and the fluid suction ports 28, both of which open at the operation surface K2. The fluid supply ports 27 and the fluid suction ports 28 may be arranged irregularly in the order of the fluid supply port 27, a fluid supply port 27, a fluid suction port 28, a fluid supply port 27, a fluid supply port 27, a fluid suction port 28, ···, for example.

(0027)

The cleaning nozzles 12 and 15 are turned a quarter rotation about respective central axes O_1 and O_2 (see FIG. 4) by rotating mechanisms (not shown) to switch between the operation surfaces K1 and K2. Therefore, each of the cleaning nozzles 12 and 15 can process the substrate W with use of different kinds of fluids. Specifically, the operation surface K1 may perform a chemical liquid process or an etching process, and subsequently the operation surface K2 may perform a rinsing process using pure water or the like after the process performed by the operation surface K1, so that the fluid remaining on the substrate W due to the process performed by the operation surface K1

is replaced with the rinsing liquid. In the illustrated embodiment, the cleaning nozzles 12 and 15 supply a processing liquid from the operation surfaces K2, respectively, so as to process the upper and lower surfaces of the substrate W.

(0028)

As shown in FIG. 6(a), the respective fluid supply ports and the respective fluid suction ports should preferably be spaced from the surface of the substrate W by an equal distance, and the respective fluid suction ports should also preferably be spaced from the surface of the substrate W by an equal distance. With this arrangement, the fluid is supplied from the fluid supply ports, all of which are positioned at the same distance from the substrate W, and hence the substrate W can be uniformly processed. Further, the fluid is sucked through the fluid suction ports, all of which are positioned at the same distance from the substrate W, and hence suction forces of all the fluid suction ports 228 can be kept equal to each other.

(0029)

A distance between tip ends of the fluid supply ports 27 and the surface of the substrate W is preferably not more than 2 mm, more preferably not more than 0.5 mm. Similarly, a distance between tip ends of the fluid suction ports 28 and the surface of the substrate W is preferably not more than 2 mm, more preferably not more than 0.5 mm. In this case, the distance between the fluid supply ports 27 and the surface of the substrate W and the distance between the fluid suction ports 28 and the surface of the substrate W may not be equal to each other. Since the fluid supply ports 27 and the fluid suction ports 28 are disposed close to the substrate W, the fluid supplied to the substrate remains stationary relative to the substrate W and a suction efficiency is improved. The fluid is supplied from each of the fluid supply ports 27 preferably at a flow rate ranging from 1 to 30 mL/min. If a chemical liquid is to be supplied so as to react with the surface of the substrate W, then the chemical liquid is supplied from each of the fluid supply ports 27 preferably at a flow rate ranging from 1 to 10 mL/min, more preferably at a flow rate ranging from 1 to 5 mL/min. For example, if a wafer having a diameter of 200 mm is to be processed, then the flow rate of the fluid for use in cleaning one-side surface of the wafer is about 30 mL/min. Since an amount of the fluid to be

supplied to the substrate is very small, the scattering of the fluid during the process is extremely suppressed. In addition, an amount of the fluid remaining on the processed substrate can be very small. In order to prevent the fluid suction ports 28 from directly sucking the fluid supplied from the fluid supply ports 27 to the substrate W, the fluid supply ports 27 and the fluid suction ports 228 should preferably be spaced from each other by a distance "s" and should preferably project from the operation surface K1 (or K2) by a height "d" (see FIG. 6(a)). Each of the distance "s" and the height "d" should preferably be at least 1 mm.

(0030)

The cleaning nozzles 12 and 15 are reciprocated in the radial direction of the substrate W as indicated by the arrow in FIG. 5. The extending directions of the cleaning nozzles 12 and 15 and the reciprocating directions of the cleaning nozzles 12 and 15 are not necessarily on the same line as each other. As shown in FIG. 6(a), the cleaning nozzle supplies the fluid from the fluid supply ports 27 positioned close to the substrate W to the substrate W such that the supplied fluid is stationary on the substrate W. Further, after a certain time has past, the cleaning nozzle 15 sucks and removes the fluid remaining on the substrate W through the fluid suction ports 28 which are spaced from the fluid supply ports 27. In contrast thereto, the conventional apparatus removes a fluid on the substrate utilizing a centrifugal force produced by a high-speed rotation of the substrate.

According to the cleaning nozzles (substrate cleaning units) 12 and 15, the fluid is supplied to the substrate W in a stationary state in which the fluid is not moved relative to the substrate W. After the supplied fluid has remained on the substrate W for a certain period of time to sufficiently react with the surface of the substrate W, the fluid suction ports 28 are moved as the cleaning nozzles 12 and 15 are reciprocated in the radial direction of the substrate W and suck the fluid that has reacted with the surface of the substrate W. In other words, the fluid supply ports 27 are reciprocated in the radial direction of the substrate W while supplying the fluid (liquid) to the substrate W which is being rotated so that the entire surface of the substrate W is coated or printed with a thin liquid film having a substantially uniform thickness. In this case, it is preferable to

lower a flow velocity of the fluid. Specifically, the flow velocity of the fluid (liquid) is preferably not more than 5 m/s, more preferably not more than 1 m/s. A rotational speed of the substrate W is preferably not more than 500 min^{-1}, and more preferably not more than 100 min^{-1}.

(0031)

The above method based on the combination of supply and suction of the fluid is capable of greatly reducing an amount of the fluid to be used, compared with a general method in which a fluid is supplied to a central portion of a substrate to clean the substrate while spinning the substrate. Since the fluid is supplied onto the substrate W and then sucked therefrom, the fluid is prevented from being scattered. The amount and thickness of the fluid remaining on the substrate W are kept constant over the entire surface of the substrate at all times because the fluid is sucked from the substrate. Therefore, the stability and uniformity of the process can be improved.

(0032)

As described above, the cleaning nozzles 12 and 15 supply the fluid (liquid) to desired positions such that the supplied fluid is stationary on the substrate W. This method is different from a conventional method in which the liquid is spread over the entire surface of the substrate by rotating the substrate at a high speed. In this embodiment, it is preferable to rotate the substrate W at a low speed of about 100 min^{-1} when the substrate W is being processed. Generally, in the conventional method in which the fluid is supplied to the central portion of the substrate and the substrate is rotated so as to spread the fluid over the entire substrate, if the substrate has a diameter of 200 mm, it is necessary to rotate the substrate at 500 min^{-1} and supply the fluid at a flow rate of at least 0.5 L/min to one-side surface of the substrate. In contrast thereto, according to the present embodiment, since the cleaning nozzles 12 and 15 perform the supply and the suction of the fluid repetitively, it is possible to sufficiently clean the substrate with the fluid supplied at a flow rate of about 30 mL/min.

(0033)

Periods of the reciprocating movements of the cleaning nozzles in the radial direction of the substrate W are required to be longer than a rotational period of the

substrate W. If the rotational period of the substrate W and the periods of the reciprocating movements of the cleaning nozzles are the same as each other, then the fluid is supplied and sucked at a constant position on the substrate W at all times, thus causing a non-uniform process. In contrast thereto, if the periods of the reciprocating movements of the cleaning nozzles are longer than the rotational period the substrate W, then the substrate W makes several rotations, for example, while the cleaning nozzles make one reciprocating movement. As a result, the fluid is supplied to and sucked from the substrate in a swirling pattern (see FIGS. 6(b) and 6(d)). On the other hand, if the periods of the reciprocating movements of the cleaning nozzles 12 and 15 are shorter than the rotational period of the substrate W, then trace of the fluid on the substrate W becomes very complicated (see FIG. 6(c)). In the present embodiment, since the fluid is sucked from the substrate W after a certain time has passed from when the fluid is supplied to the substrate, a sufficient time is given to the reaction of the fluid, thus enabling a uniform process.

(0034)

When the fluid supply ports 27 and the fluid suction ports 28 perform a reciprocating movement, they should preferably be stopped at stroke ends for not more than 0.5 second. A time for which the cleaning nozzle 12 (or 15) is stopped when being reversed at the stroke ends is preferably as short as possible because the fluid is supplied to the same portion of the substrate W during such a time. For example, if a period of the reciprocating movement of the cleaning nozzle 12 (or 15) is 5 seconds, then the cleaning nozzle 12 (or 15) should preferably be stopped at the stroke ends for not more than 0.5 second, or more preferably for not more than 0.1 second.

(0035)

As shown in FIG. 5, the fluid supply ports and fluid suction ports of the cleaning nozzle should preferably be movable in the radial direction of the substrate W within a movement range which does not include the central portion and the edge portion of the substrate W. If the fluid supply port is moved to the central portion, then the central portion is supplied with a greater amount of the fluid than other areas of the substrate W, which is not preferable. Therefore, as shown in FIG. 5, it is preferable that the

movement range of the fluid supply ports is set be close to the central portion, but does not include the central portion. If the fluid is supplied to the edge portion of the substrate W, then the fluid is possibly scattered out of the substrate W. Therefore, it is necessary to limit the movement range of the fluid supply ports.

(0036)

In the cleaning nozzles (substrate cleaning units) shown in FIG. 4, the fluid supply ports and the fluid suction ports are arranged linearly at constant intervals. However, the above-mentioned cleaning function can be achieved even if the fluid supply ports and the fluid suction ports are not arranged linearly at constant intervals. In the present embodiment, each of the cleaning nozzles has the two operation surfaces each having the fluid supply ports and the fluid suction ports. However, fluid supply ports and fluid suction ports for a certain type of fluid may be provided in one of the operation surfaces, and only fluid supply ports for other type of fluid may be provided in the other one of the operation surfaces. The number of operation surfaces is not limited to two. Specifically, three, four or more operation surfaces each having the fluid supply ports and the fluid suction ports may be provided. Further, the cleaning nozzles 12 and 15 may have a polygonal or circular cross-sectional shape, or may be of a structure having two or more operation nozzle groups. As shown in FIG. 4, the cleaning nozzles 12 and 15 may also have a combined polygonal and circular cross-sectional shape.

(0037)

As shown in FIG. 4, it is preferable to provide a plurality of the fluid supply ports 27. In this case, it is preferable to control flow rates of the fluid supplied from the respective fluid supply ports. Specifically, apertures of the fluid supply ports are preferably adjusted such that the flow rates of the fluid supplied from the respective fluid supply ports are increased gradually from the central side to the peripheral side of the substrate W. Because the cleaning nozzle supplies the fluid to the substrate which is being rotated, the surface area to be supplied with the fluid per unit time is increased from the central side to the peripheral side of the substrate. Therefore, it is necessary to increase the flow rates of the fluid to be supplied from the fluid supply ports from the central side to the peripheral side of the substrate so as to cope with the increase in

surface area. By increasing the flow rates from the central side to the peripheral side of the substrate, it is possible to uniformly supply the fluid over the entire surface of the substrate.

(0038)

It is preferable to provide a device for monitoring the flow rate of the fluid supplied from at least one of the fluid supply ports 27. For example, by measuring a supply pressure of the fluid, the flow rate and flow velocity of the fluid supplied from each of the fluid supply ports 27 can be calculated based on the aperture or size of the fluid supply port 27. Further, by controlling the supply pressure of the fluid so as to achieve predetermined flow rate and flow velocity, an accuracy of the flow rate and flow velocity of the fluid such as a cleaning liquid can be increased. Furthermore, this substrate processing apparatus should preferably have a temperature controller for warming and/or cooling the fluid. In some cases, a substrate processing capability of the fluid may depend on the temperature of the fluid. In such cases, the temperature of the fluid should preferably be adjusted to an appropriate value. The temperature controller may comprise a heater or a cooling unit provided on a pipe for supplying the fluid. On the other hand, each of the fluid suction ports 28 also has a structure which can adjust its conductance (a shape and size thereof). The fluid suction ports 28 communicate with a common vacuum source or a plurality of vacuum sources, respectively, so that the fluid suction ports 28 suck the processing fluid under a certain suction pressure which has been adjusted to a predetermined value. In this case, by setting the respective apertures of the fluid suction ports 28 to desired values, it is possible to change a flow rate of the fluid sucked through each of the fluid suction ports 28. Once the aperture of each fluid suction port 28 is set, the flow rate (flow velocity) of the fluid sucked therethrough can be changed by changing a suction force of the vacuum source. It is preferable that the flow rate of the fluid sucked through each of the fluid suction ports 28 is lower than the flow rate of the fluid supplied from each of the fluid supply ports 27 with respect to the same radial positions of the substrate W. It is also preferable to equalize the flow rates of the fluid sucked through the respective fluid suction ports 28 or reduce these flow rates gradually from the central side to the

peripheral side of the substrate W. In other words, in order to uniformly process the entire surface of the substrate, it is preferable to form a film of the processing liquid over the entire surface of the substrate with a uniform thickness at all times and to replace the processing liquid with a new processing liquid at a uniform replacement speed in every region of the surface of the substrate by supplying and sucking the processing liquid.

(0039)

The substrate processing apparatus may also have a device for controlling the process of the substrate (wafer) based on processing conditions. Examples of the processing conditions include the rotational speed of the substrate, the distances between the upper and lower surfaces of the substrate and the cleaning nozzles 12 and 15, the periods, average speeds, and maximum speeds of the reciprocating movements of the cleaning nozzles 12 and 15, the pressure and temperature of the fluid to be supplied, the vacuum degree of the vacuum source, and the type of fluid (liquid). These processing conditions are set according to the type of substrate or the type of film formed on the surface of the substrate. Measured values corresponding to these processing conditions are monitored while the substrate is being processed. These measured values are compared with preset date of the processing conditions, and the process of the substrate is controlled in such a manner that the measured values are kept equal to the preset data.

(0040)

The substrate processing apparatus may have an arrangement in which the cleaning nozzle 15 is disposed below the substrate and a bevel cleaning nozzle is disposed above the bevel portion (peripheral portion) of the substrate. With this arrangement, the lower surface of the substrate W can be cleaned or etched by the cleaning nozzle 15 at the same time that the upper-surface-side bevel portion of the substrate W is processed by the bevel cleaning nozzle. Alternatively, the substrate processing apparatus may have an arrangement in which the cleaning nozzle 12 is disposed above the substrate and a bevel cleaning nozzle is disposed below the bevel portion (peripheral portion) of the substrate W for processing the lower-surface-side bevel portion of the substrate.

(0041)

It is preferable that the substrate processing apparatus has a unit for recovering the fluid (liquid) sucked through the fluid suction ports and reusing the recovered fluid. For example, the used fluid may be recovered in a recovery tank, and may be returned to a fluid supply tank of the substrate processing apparatus after the fluid is filtered. It is also preferable that the substrate processing apparatus has a unit for regenerating the recovered fluid so as to reuse the fluid. The substrate processing apparatus may also have a unit for monitoring a concentration of the recovered or regenerated fluid, or a concentration of impurities contained in the fluid.

(0042)

FIGS. 7 and 8 schematically show a substrate processing apparatus according to another embodiment of the present invention. FIG. 9 shows a system arrangement of the substrate processing apparatus according to the embodiment. The substrate processing apparatus 1' has the same basic structure as the above-mentioned embodiments. Specifically, the substrate processing apparatus 1' comprises substrate holders 11a, 11b, 11c and 11d comprising rollers 20 for holding and rotating a substrate W, holder suction nozzles 24 for sucking a processing liquid, and holder cleaning nozzles 26 for supplying a cleaning liquid to clamp portions 21 of the rollers 20. However, in this embodiment, only a cleaning nozzle 15 is disposed below the substrate W, and a purge plate 38, which is horizontally and vertically movable, is disposed above the substrate W. The purge plate 38 has at least one opening (not shown) for supplying an inert gas such as an N_2 gas to the substrate W so as to prevent a mist of the fluid (liquid) or a chemical liquid atmosphere produced at the lower surface of the substrate W from contaminating or deteriorating the surface of the substrate. The purge plate 38 may have only one opening at a position corresponding to the central portion of the substrate W, or may have a plurality of openings disposed on a plurality of circles arranged concentrically to the substrate W at radially equal intervals.

The substrate processing apparatus 1' further comprises a bevel cleaning nozzle (periphery cleaning unit) 36 for cleaning an upper-surface-side peripheral portion (bevel portion) of the substrate W with a cleaning liquid and a bevel suction nozzle (periphery suction unit) 37 for sucking the cleaning liquid. The bevel cleaning nozzle 36 is

disposed adjacent to the bevel suction nozzle 37 and located forward of the bevel suction nozzle 37 in the rotational direction of the substrate W. Therefore, the cleaning liquid supplied from the bevel cleaning nozzle 36 is sucked by the bevel suction nozzle 37 immediately before the substrate W makes one rotation in the direction indicated by the arrow. The substrate processing apparatus 1' is thus capable of cleaning the lower surface of the substrate W and processing, e.g., cleaning, the upper-surface-side bevel portion of the substrate W. The substrate processing apparatus 1' is also capable of etching the substrate W and then cleaning the substrate W using the bevel cleaning nozzle 36 and the bevel suction nozzle 37. The bevel cleaning nozzle 36 and the bevel suction nozzle 37 are moveable by motors M, respectively, in the radial direction of the substrate W in order to adjust their positions when processing the bevel portion of the substrate W. The bevel cleaning nozzle 36 and the bevel suction nozzle 37 may be reciprocated between the center portion and the peripheral portion of the substrate W so as to process the entire surface of the substrate W. The purge plate 38 has a substantially circular shape such that the purge plate 38 does not cover the edge portion of the substrate W and is not brought into contact with the bevel cleaning nozzle 236 and the bevel suction nozzle 237.

(0043)

In this substrate processing apparatus 1', as shown in FIG. 9, a liquid such as a chemical liquid is delivered from a liquid delivery tank 31 to the cleaning nozzle 15, and then supplied from the fluid supply ports of the cleaning nozzle 15 onto the surface of the substrate W. The cleaning nozzle 15 is reciprocated in a horizontal plane as indicated by the arrow in FIG. 9 by an actuating mechanism, and recovers the chemical liquid, which has been supplied to the substrate W, through the fluid suction ports. The chemical liquid recovered through the fluid suction ports is delivered to the recovery tank (gas-liquid separating tank) 32 which separates a gas and the chemical liquid from each other. The separated chemical liquid is then delivered to a circulation tank 33.

(0044)

The used chemical liquid that is stored in the circulation tank 33 is pressurized by a pump P, filtered by a filter 34, adjusted in temperature by a temperature controller

35, and then returned as a reusable chemical liquid to the liquid delivery tank 31. In this manner, the chemical liquid is circulated for reuse and an amount of the chemical liquid to be used for process can be small. The chemical liquid supplied from the bevel cleaning nozzle 36 is sucked by the bevel suction nozzle 37 and can be also reused in the same manner as described above. Although not shown, the substrate processing apparatus 1' has a unit for regenerating the used chemical liquid returned to the circulation tank 33, so that the used chemical liquid is reused.

(0045)

FIG. 10 is a schematic plan view showing a substrate processing unit 71 incorporating the substrate processing apparatus 1 or 1'. As shown in FIG. 10, the substrate processing unit 71 comprises two wafer cassettes 81A and 81B for accommodating a plurality of substrates W such as semiconductor wafers therein, a substrate plating apparatus 84 for plating the substrate W, a substrate etching apparatus 82 for etching the substrate W, and the substrate processing apparatus 1 (or 1') for cleaning and drying the substrate W which has been etched. The substrate processing unit 71 further comprises a first transfer robot 85A and a second transfer robot 85B for transferring the substrate W from one to another of the above-mentioned apparatuses. The substrate processing unit 71 further comprises a buffer stage 86 having upper and lower shelves on which the two substrates W are temporarily placed separately when the substrate W is transferred between the first transfer robot 85A and the second transfer robot 85B. In this substrate processing unit 71, either of the substrate plating apparatus 84 and the substrate etching apparatus 82 is a single-wafer processing apparatus which processes the substrate one by one, as with the substrate processing apparatus 1 or 1'.

(0046)

Each of the wafer cassettes 81A and 81B has a plurality of shelves (not shown) so that the substrates W are accommodated in the shelves, respectively. One of the substrates W accommodated in the wafer cassette 81A (or 81B) is removed by the first transfer robot 85A, and is transferred to the second transfer robot 85B via the buffer stage 86. The substrate W is transferred to the substrate plating apparatus 84 by the second transfer robot 85B, and is then plated in the substrate plating apparatus 84. Next, the

substrate W is transferred to the substrate etching apparatus 82, and is then etched in the substrate etching apparatus 82. The substrate etching apparatus 82 may be constructed to have the same structure as the substrate processing apparatus 1 (or 1') so that the cleaning nozzles 12 and 15 supply an etching liquid instead of supplying a cleaning liquid.

(0047)

Alternatively, the substrate processing apparatus 1 (or 1') may perform an etching process, a cleaning process, and a drying process, without providing the substrate etching apparatus 82. The substrate etching apparatus 82 may be replaced with the substrate processing apparatus 1 (or 1') so that the two substrate processing apparatuses 1 (or 1') perform the etching process, the cleaning process, and the drying process simultaneously. With this arrangement, in a case where a processing time of the substrate plating apparatus 84 is shorter than that of the substrate processing apparatus 1, the two substrate processing apparatuses 1 (or 1') are operated simultaneously (i.e., in a parallel processing manner) for thereby improving a processing capability (through put) of the substrate processing system 71.

(0048)

After the etching process is performed by the substrate etching apparatus 82, the substrate W is transferred to the substrate processing apparatus 1 or 1' by the second transfer robot 85B. In the substrate processing apparatus 1 or 1', the processing fluid is supplied to and sucked from the upper and lower surfaces of the substrate W by the cleaning nozzles 12 and 15 while the substrate W is held and rotated in the manner as described above, thereby cleaning the upper surface and the lower surface of the substrate W. Accordingly, reaction products that have been produced by the etching process are washed out by the substrate processing apparatus 1. Particularly, fine particles on the surface and fine particles in recesses of the surface of the substrate W are removed. Specifically, a first cleaning process may be performed with use of an acid cleaning liquid such as fluorinated acid, and a second cleaning process may be performed with use of an alkaline cleaning liquid.

(0049)

After the cleaning process, the drying gas is supplied from the gas supply nozzles 13 and 14 to the upper and lower surfaces of the substrate W, thereby drying the substrate W which has been cleaned. The dried substrate W is successively transferred from the substrate processing apparatus 1 (or 1') to the wafer cassette 81A (or 81B) by the second transfer robot 85B and the first transfer robot 85A through the buffer stage 86. The substrate W is then accommodated in the wafer cassette 81A (or 81B), and a sequence of the processes is thus completed. In this manner, the substrate processing apparatus 1 (or 1') according to the embodiment is suitable for use in the substrate processing system 71 which performs various kinds of processes such as the plating process, the etching process, the cleaning process, and the drying process. Particularly, the substrate processing apparatus 1 (or 1') can perform the cleaning process and the drying process at a high efficiency and a high quality. The substrate processing apparatus 1 (or 1') can also shorten an operation time and can contribute to the improvement of a yield of products. In this substrate processing system 71, the substrate etching apparatus 82 and the substrate plating apparatus 84 may be replaced with a bevel etching apparatus for etching a bevel portion of the substrate, a bevel polishing apparatus for polishing the bevel portion of the substrate, an electrolytic polishing apparatus for performing an electrolytic polishing on a plated layer or the like, or a CMP apparatus for performing a chemical mechanical polishing on the surface of the substrate. Alternatively, the substrate etching apparatus 82 and the substrate plating apparatus 84 may be replaced with the substrate processing apparatuses 1 (or 1'), respectively, so that the substrate processing system 71 has three substrate processing apparatuses 1 (or 1') for performing the etching process and/or the cleaning process and the drying process simultaneously.

(0050)

Although the preferred embodiments of the present invention have been described above, the present invention is not limited to the above embodiments, but may be practiced in various forms within the scope of the technical concept thereof. The present invention is not limited to the illustrated embodiments, but various changes may be made therein without departing from the scope of the invention.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(0051)

(FIG. 1) FIG. 1 is a plan view schematically showing a substrate processing apparatus according to an embodiment of the present invention.

(FIG. 2) FIGS. 2(a) and 2(b) are views showing a structure of the substrate holder.

(FIG. 3) FIG. 3 shows the manner in which the substrate processing apparatus shown in FIG. 1 cleans a front surface (an upper surface) and a back surface (a lower surface) of a substrate W.

(FIG. 4) FIG. 4 shows a specific structure of the cleaning nozzles.

(FIG. 5) FIG. 5 is a schematic view illustrating a reciprocating movement of the cleaning nozzle shown in FIG. 4.

(FIG. 6) FIG. 6(a) is a view illustrating the manner in which a fluid (liquid) is supplied to and sucked from a substrate; FIG. 6(b) is a view illustrating the manner in which the liquid is supplied in a swirling pattern; FIG. 6(c) is a view illustrating the manner in which the liquid is supplied unstably; and FIG. 6(d) is a view showing traces of the fluid supply port and the fluid suction port in a reciprocating movement.

(FIG. 7) FIG. 7 is a plan view schematically showing an essential part of a substrate processing apparatus according to another embodiment of the present invention.

(FIG. 8) FIG. 8 is a cross-sectional view showing the substrate processing apparatus shown in FIG. 7.

(FIG. 9) FIG. 9 is a block diagram showing a system structure of the substrate processing apparatus shown in FIG. 7.

(FIG. 10) FIG. 10 is a schematic plan view showing a substrate processing unit incorporating the substrate processing apparatus in FIG. 1 or FIG. 7.

(EXPLANATION OF REFERENCE NUMERALS)

(0052)

1, 1' substrate processing apparatus

10 chamber

11a, 11b, 11c, 11d substrate holder

12, 15	cleaning nozzle
13, 14	gas supply nozzle
16	bevel suction nozzle
20	roller
21	clamp portion
23	suction mouth
24	holder suction nozzle
25	supply mouth
26	holder cleaning nozzle
27	fluid supply port
28	fluid suction port
29	supply pipe
30	discharge pipe
31	liquid delivery tank
32	recovery tank (gas-liquid separating tank)
33	circulation tank
34	filter
35	temperature controller
36	bevel cleaning nozzle
37	bevel suction nozzle
38	purge plate
71	substrate cleaning unit
81A, 81B	wafer cassette
82	substrate etching apparatus
84	substrate plating apparatus
85A, 85B	transfer robot

(NAME OF DOCUMENT) ABSTRACT

(ABSTRACT)

(PURPOSE) An object of the present invention is to provide a substrate processing apparatus and a substrate processing method which can prevent a fluid such as a processing liquid from being scattered from a substrate and can reduce an amount of the liquid to be used and can improve a uniformity of a process on the surface of the substrate.

(MEANS FOR SOLUTION) The substrate processing apparatus includes a substrate holder 11 for holding and rotating a substrate W, at least one fluid supply port 27 for supplying a fluid to the substrate W which is being rotated, and at least one fluid suction port 28 for sucking the fluid on the substrate. The fluid supply port and the fluid suction port are disposed close to the substrate. The fluid supply port 27 and the fluid suction port 28 are movable in the radial direction of the substrate W.

(SELECTED DRAWING) FIG. 4